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DOI:
10.1123/japa.2016-0287

Document Version
Peer reviewed version

Citation for published version (Harvard):
Castaneda Gameros, D, Redwood, S & Thompson, J 2017, 'Physical activity, sedentary time, and frailty in older migrant women from ethnically diverse backgrounds: a mixed-methods study.', *Journal of aging and physical activity*. https://doi.org/10.1123/japa.2016-0287

Physical Activity, Sedentary Time, and Frailty in Older Migrant Women from Ethnically Diverse Backgrounds: A Mixed-Methods Study

Original Research

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Abstract

There is limited evidence examining the association between physical activity (PA), sedentary time (ST), frailty, and factors influencing PA behaviors in migrant older women from ethnically diverse backgrounds. The aims of this mixed-methods study were to: 1) examine PA levels and ST across frailty status; 2) identify any differences in PA/ST between ethnic and religious groups; and 3) qualitatively explore factors influencing PA among older (≥60 years) migrant women (n=60). PA/ST were assessed using accelerometry and frailty status using the frailty phenotype. Key factors influencing PA were explored via semi-structured interviews (n=36) and analyzed using thematic analysis. Participants were highly sedentary irrespective of frailty status. Moderate-to-vigorous-physical activity (MVPA) was independently associated with frailty. Participants spent 69% of waking time in ST, with only 15% meeting current weekly PA recommendations. Health-related and socio-cultural factors were reported as common barriers to achieving PA recommendations. Maintaining independence, preventing physical decline and depression were key factors promoting PA. Understanding the challenges and needs of this population can help to inform strategies to promote PA and thus optimize physical function.

Key words: physical activity, frailty, ethnicity, interviews.

Background

Due to the burgeoning ageing population, there is an increased focus on strategies to improve older adults' health and well-being (Rechel, Grundy, Robine, Cylus et al., 2013). Increased prevalence of chronic diseases and age-related physical decline often results in high levels of frailty among older adults (Christensen, Doblhammer, Rau, & Vaupel, 2009). Conceptually, frailty has been defined as a pathological condition that results in a cumulative decline in multiple physiological systems over the lifetime (Clegg et al., 2013). The most widely used definition was proposed by Fried et al. (2001), which identifies someone as frail by the presence of three or more of five criteria (unintentional weight loss, exhaustion, weakness, slow walking speed, and low physical activity). Frailty is an important health concern as it has been associated with increased risks of falls, fractures, disability and premature death among older women (Boyd et al., 2005; Ensrud et al., 2007).

Physical activity (PA) has previously been investigated as an important lifestyle behavior that could help slow down the decline of muscle mass and strength associated with frailty (Cruz-Jentoft et al., 2010). Current PA guidelines advise older adults to engage in at least 150 minutes per week in moderate-to-vigorous physical activity (MVPA) in bouts of 10 minutes or more, or in 75 minutes of vigorous PA per week, or a combination of both (DoH, 2011). Despite the known benefits, PA declines with age and consequently, older adults tend to spend many hours being sedentary (Matthews et al., 2015). Although previous studies have investigated the association between PA and sedentary time (ST; time spent sitting or lying) and frailty (Da Silva et al., 2016; Blodgett, Theou, Kirkland, Andreou & Kirkwood, 2015a; Marques, Baptista, Santos, Silva, Mota & Sardihna, 2014), this association has

not been investigated in older migrant women from ethnically diverse backgrounds. Examining this is important, since older adults (≥55 years) from minority ethnic backgrounds, especially women from Indian, Pakistani, and Bangladeshi origin, report being less likely to meet the recommendations of PA than their White counterparts (Sproston & Mindell, 2006).

Moreover, in order to develop effective interventions to promote PA and consequently decrease the risk for frailty among older migrant women, it is important to know what factors influence their PA behaviors. Previous studies have found important determinants of PA among minority groups living in the United Kingdom (UK), including cultural beliefs. However, they mainly focus on South Asian populations, particularly Indians and Pakistanis (Sriskantharajah & Kai, 2007; Babakus & Thompson, 2012; Horne & Tierney, 2012). Thus studies including older women from less established migrant groups are needed.

Given the lack of evidence on the associations between PA/ST and frailty and the limited evidence on key factors influencing PA behaviors in migrant older women from ethnically diverse backgrounds, the aims of this study were to: 1) examine levels of PA/ST in migrant older women across frailty status; 2) identify any differences in PA/ST between ethnic and religious groups; and 3) qualitatively explore key factors influencing PA among this sample.

Methods

Study design

A sequential mixed-methods approach was employed to build a deeper insight into PA/ST levels and their association with frailty in an under-studied population group. The first phase of the study involved assessing objectively measured PA/ST

and frailty status. The second phase employed semi-structured interviews to further explore key factors influencing PA behaviors and participant's views on the link between PA and frailty. The ethical review committee of the University of XXX granted approval for the study (reference No. XXX). Written informed consent was obtained from all participants. Data were collected between January 2013 and June 2015.

Participants

This convenience sample consisted of 60 first generation migrant women who were recruited for a larger study exploring dietary and PA behaviors within the context of migrating to, and ageing in, the UK. Participants were recruited using maximum variation sampling (Teddlie & Yu, 2007) to achieve our goal of recruiting a sample across the range of age, migration backgrounds, level of deprivation, and predominant ethnic groups living in the geographic region. Recruitment was initiated with contacts in the community and snowballing, with additional purposive sampling done via community centers in [city name] and surrounding areas. A sub-sample (n=36) was purposively selected to participate in semi-structured interviews, based on age, ethnicity, as well as socio-economic and migration backgrounds to represent the diversity of the study population.

Phase 1: Quantitative data collection

Objective assessment of PA and ST. PA and ST levels were measured using Actigraph GT3X accelerometers (Actigraph, Pensacola, FL) programmed to record activity in 60-second epochs. Participants were instructed to wear the device on the hip for a period of 7 days, only removing for bathing, swimming and sleeping. To be included in the analysis, participants had to wear the device for at least 3 days

including one weekend day, and for at least 10h/day of valid wear time (Curry & Thompson, 2014).

Data were cleaned and scored using ActiLife software (version 6.2, Actigraph). Non-wear time was defined as 90 consecutive minutes of zero counts, with an allowance of 2-minutes of nonzero counts provided there were 30-minute consecutive zero count windows up and downstream (Choi, Matthews & Buchowski, 2011). The cut-off points for ST (<100 counts/minute) and MVPA (≥1,952 counts/minute) were chosen based on previous literature, therefore ensuring the findings from this study are comparable with other populations, including older adults (Buman et al., 2010). The Copeland & Esliger threshold (2009) was used to define light PA (LPA) into two different categories given the wide range of activities that are classified as LPA (e.g., standing and slow walking). The threshold distinguishes between low-light PA (LLPA; 100-1,040 counts/minute) and high-light PA (HLPA; 1,041-1,951 counts/minute). Among older adults, the time spent in the upper end of LPA may provide a greater beneficial effect on health in comparison to the lower threshold (Copeland & Esliger, 2009).

Frailty. Frailty was determined following a modified version of the original 5-item frailty phenotype (Fried et al., 2001), including:

1. Exhaustion: assessed by self-reported fatigue, using two questions from the CES-D questionnaire (Radloff, 1977) including "I felt that everything I did was an effort" and "I could not get going". Participants responding yes for ≥3 days over the previous week to either of both questions received a positive score for exhaustion.
2. Weakness: measured in kg using a Jamar hand-held dynamometer (Sammons Preston Rolyan, Bolingbrook, Illinois, USA). Participants met the criteria for

weakness if their BMI and grip strength were ≤ 12 kg for BMI ≤25.8; ≤ 11 kg for BMI >25.9- 29.6; ≤12 kg for BMI >29.7- 31.6, and ≤14 kg for BMI >31.7.

3. Slow walking: assessed by a 15ft walk at one's usual pace, the slowest quintiles adjusted by height were >14.5 seconds for height ≤ 157.7 cm and >9.7 seconds for height > 157.7 cm.
4. Low PA: estimated using the International Physical Activity Questionnaire modified for the elderly. Participants with a caloric expenditure of <60 Kcal/week (lowest quintile) scored positive for low levels of PA.
5. Poor nutritional status: estimated using 24hr-recalls and defined as low intake of >3 out of 9 nutrients (protein <30 g, vitamin D <0.5 μg, vitamin E <2.5 mg, retinol <101 μg, vitamin C <32 mg, folate <127 μg, iron <5.6 mg, calcium <349 mg, and zinc <3.6 mg). We used poor nutritional status in the definition of frailty instead of unintentional weight loss, as it has been shown to be a better measurement of dietary inadequacy in this sample (XXX et al., in press).

Similar to Fried et al. (2001), cut-offs for a positive score for weakness, slow walking, low PA, and low nutrient intakes were set at the lowest 20% of the sample. Participants with >3 positive criteria were categorized as frail, while those with 1-2 and 0 were classified as pre-frail and non-frail, respectively.

Other characteristics. Descriptive data included measured weight (to the nearest 0.1 kg) and height (to the nearest 1 cm). Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). The World Health Organization BMI cut-points for Asian populations were used for the Arab, Bangladeshi, Indian, and Pakistani participants (WHO, 2004).

A researcher-administered questionnaire provided information on the following: age, self-reported ethnicity, religion, marital status, medication, and diagnosed medical conditions. As a socio-economic indicator, each participant's residential postcode was used to assign an area deprivation score using The English Index of Multiple Deprivation (IMD) score—a UK government-produced measure of area deprivation that includes assessments of income, employment, health and education (Department for Communities and Local Government, 2011).

Phase 2: Qualitative data collection.

Semi-structured interviews. The interview guide was designed to guide the exploration of: 1) perceived barriers to engage in PA; 2) views about the official PA recommendations; and 3) perceived role of PA in maintaining physical function. Since different translators were used depending on the participants' language needs, they were instructed to discuss PA in terms of any activity participants engaged in, from housework, to general walking, and formal exercises in walking groups or community and/or leisure centers. The interview guide was piloted and further revised via an iterative process throughout data collection. Interviews were carried out with women from all ethnic groups until data saturation was reached (Guest & Johnson, 2006). A trained interpreter translated interviews conducted with non-English speakers into English during the interview process (n=16). All interviews were audio recorded and transcribed verbatim.

Data analysis.

Quantitative analysis. Descriptive statistics (means, SDs, percentages) were calculated for all participant characteristics. One-way ANOVAs or Chi-square/Fisher's exact tests were used to compare differences between frailty groups.

One-way ANCOVAs with Bonferroni's post hoc tests were used to compare differences in PA/ST between frailty groups adjusted for age and wear time. Data were also analyzed by ethnicity. However, given the small number of Arab and White Irish participants and due to their non-significant differences in PA/ST and frailty (data not shown), these two ethnic groups were categorized into "other" ethnic group. In an attempt to take into consideration that PA in ethnic minority groups is greatly influenced by cultural and religious beliefs (Caperchione et al., 2009; Babakus & Thompson 2012), we also analyzed our data by religion/faith affiliation.

Multiple regression analyses were performed to examine if PA/ST were predictive of frailty, in which the total number of components of the frailty phenotype was the outcome variable (frailty score). Because our aim was to establish an association between PA/ST and the frailty syndrome, we did not include self-reported PA in our frailty score. Potential confounders were selected based on the literature and the purpose of the study, including age, marital status, IMD, BMI, religion, and wear time. MVPA data was log-transformed for the analysis. All statistical analyses were conducted using SPSS version 21.0 (IBM Corp, Armonk, NY, 2012); alpha was set at $p< 0.05$.

Qualitative analysis. Data were analyzed using thematic analysis based on the recommendations of Braun & Clarke (2006) in which themes are drawn from the data inductively, rather than fitting into a pre-existing theory. Initially, the first author and two research assistants read and re-read a set of transcripts to familiarize themselves with the data. Initial coding was carried out using NVivo qualitative analysis software (version 10; QSR International Pty Ltd, Melbourne, Australia). The coding was reviewed and discussed by the research team to allow for the development of a coding

framework. All of the transcripts were then coded by XXX. The coding framework was refined in joint discussions with XXX and XXX until consensus was reached.

Results

Phase 1: Quantitative findings.

Out of the total 76 participants originally recruited to participate in this study, 16 were excluded for the following reasons: dropping out of the study for health reasons (n=1), losing the accelerometer (n=1), trust issues (n=1), lost to follow-up (n=6), and failing to meet the minimum wear criteria (n=7). Participants wore the accelerometer for an average of 5.7 days (*SD*=1.3 days), for an average of 778.3 min/day (*SD*=71.9 min/day).

Participant characteristics. Table 1 shows the characteristics of the study sample. Ten participants (17%) were classified as frail, while 23 (38%) and 27 (45%) were classified as pre-frail and non-frail, respectively. The mean age of participants was 70.8 (*SD*=8.1 years). Frail participants were older than non-frail participants and more likely to be widowed. Over 88% of the sample was classified as overweight or obese. Only 15% of the sample met the recommended ≥150 minutes of MVPA per week in bouts of at least 10-min duration (DoH, 2011). None of the frail participants met the MVPA recommendations. Slow walking and poor nutritional status were the main contributors to classifying both pre-frail and frail participants, while low PA was a major contributor only for classifying frail participants. The frail group had a higher proportion scoring positive for slow walking (70 vs. 18.5%), poor nutritional status (70 vs. 37.5%) and low PA (90 vs. 37%) than pre-frail participants.

[Insert Table 1 here]

Differences in PA levels and ST across frailty groups. Participants spent an average

of 536.8 (SD= 87.8) min/day or 69% of their waking time engaged in sedentary behavior, irrespective of their frailty status (see Table 2). Although LLPA and HLPA tended to be lower in the frail group, only MVPA was significantly different between non-frail/pre-frail and frail groups (18.4 and 18.7 vs. 3.4 min/day), after controlling for age and wear time.

[Insert Table 2 here]

Differences in PA levels and ST between ethnic and religious groups. When comparisons were made by ethnicity (see Table 3), African/Caribbean participants spent more time engaged in ST than women in the SA and 'other' groups (570.1 vs. 532.8 and 481.2 min/day, respectively), as well as less time in LLPA (168.9 vs. 236.1 min/day) than women in the 'other' group. HLPA was higher in the SA and the 'other' groups in comparison with the African/Caribbean group (30.2 and 39.2 vs. 16.8 min/day, respectively). Comparisons by religious affiliation indicated that women identifying as Muslim spent more time in HLPA than those identifying as Christian (36.4 vs. 18.6 min/day).

[Insert Table 3 here]

Associations between frailty, various PA intensities, and ST. Multiple regression models examining factors predicting frailty indicated that ST, LLPA, and HLPA were not associated with frailty (data not shown). Table 4 shows the results of the significant models for frailty when MVPA and potential confounders were included. After adjustment for age, number of comorbidities, marital status, and wear time (Model 1), MVPA was inversely associated with frailty ($t=-2.22$, $p=0.03$). This inverse association remained significant after further adjustment for BMI, IMD,

religion, and ST (Model 2) (t=-2.28, p=0.04), with both models explaining 38% of the variance in frailty.

[Insert Table 4 here]

Phase 2: Interview findings.

Table 5 shows the key themes and sub-themes related to women's perceived barriers and motivators to meet the PA guidelines that where identified from the analysis. Excerpts from participants' interviews are used to illustrate the themes and sub-themes. Excerpts in the third person are those from an interview that was conducted with the aid of an interpreter.

[Insert Table 5 here]

Perceived barriers to meeting PA guidelines.

There were three important *health-related barriers* that limited PA engagement across the sample including: aging and illness, different physical abilities, and weight issues.

Aging and illness – Consistent with accelerometry data, frail participants tended to perceive themselves as inactive and commonly reported this was a consequence of "getting weaker with age", as well as having diverse medical conditions (e.g., stroke or arthritis) which have considerably affected their health and have deteriorated their physical function. Furthermore, participants reported feeling afraid of falling or worsening their health in an attempt to engage in PA. This was despite the fact that many participants had been recommended to engage in more leisure walking by their GP [General Practitioner]. Reluctance to follow health

professional advice was related to their perceived physical limitations: “The doctor's saying [to walk] but if I can’t do it even if the doctor's saying, how can I do it? (Bangladeshi, 81y, frail)”. In other cases, women have stopped exercising because of perceived negative effects of the exercise.

> I used to exercise more…I used to go swimming ‘cause the doctor used to say to swim once a week, but I just stopped it… sometimes if I go down [to swim], my knees give me a lot of trouble. (African-Caribbean, 83y, frail)

Different physical abilities– The ability of adhering to official PA recommendations was perceived differently among the sample. For participants who were already involved in some kind of activity (e.g., walking groups or community exercise sessions) and with a perceived higher physical function, PA was already part of their daily lives. Some participants also expressed their desire to engage in a wide variety of PA and not only in “boring” light PA that is commonly prescribed and offered to older adults.

> Yesterday I went to do exercise, but at first they [members of the community center] were sitting down because some of them have aches and pain so I think… sit for a while, but after that get up and start, even throw the ball, throw it to the side, pass it over your head or something…. I’d prefer zumba. (African-Caribbean, 77y, non-frail)

On the other hand, some women found meeting the PA recommendations as problematic, given that standardized guidelines may not accommodate all older women, especially those with physical limitations. One participant stressed that PA depends on one’s physical abilities: “Well, I suppose for some people it isn't if you

can't move, yeah. It is an individual thing… you can't just say that everybody has to do it! (Irish, 62y, pre-frail). This was highlighted by another participant: "Five minutes is a long time, even a minute is very long so to do 30 minutes is a long, long time for some people" (African-Caribbean, 79y, pre-frail).

Weight issues– Excessive weight was highlighted as a physical and psychological factor limiting their ability to engage in and maintain a more active lifestyle. For instance, excessive weight had caused some participants to suffer from osteoarthritis. As a consequence, some women reported being restricted from engaging in PA: "Her weight is more than her bones, so that is why she has less mobility and has to use a walking stick. She is trying her best but she can't [do PA]". (Yemeni, 77y, pre-frail). Excessive weight also caused some participants to compare themselves with younger and fit people, which discouraged them to maintain their PA habits.

> I feel fat whenever I go to the gym…because I see everybody… they are all fit and whatever. I feel like Gosh! Every time I looked at them I sort of felt massive! (African-Caribbean, 68y, frail)

Important *socio-cultural factors* were related to societal expectations of women and cultural norms that prevented engagement in leisure PA including conflicting schedules, language barriers, and cultural priorities.

Conflicting schedules– For some participants taking time to engage in leisure PA was not an easy task, especially if the activities they preferred interfered with their household responsibilities. Having to neglect their housework was perceived as

problematic, and in some cases women had to prioritize family responsibilities over time for themselves.

> They have [swimming lessons] but they've got those times, which are not appropriate. In the evening, that is the time when the husband is coming home, like 7-8 o'clock... I had to come home... not having a shower either, rushing, worrying… I have to cook for him. (Pakistani, 62y, non-frail)

In addition, even when some women did not have major responsibilities, participants explained their preference to complete all their leisure activities during the mornings and have a "quieter" time during the evenings: "I am trying to finish everything before morning time and after that it's my prayer time and you know, other things I am doing" (Pakistani, 61y, pre-frail).

Language barriers– Although many women in this sample were fluent in English, the negative influence of language barriers was reported in those who migrated later in life, and for women who did not have the opportunity to learn English given their focus on taking care of their families. Not being able to communicate and relying on others to accompany them if they want to go out of their homes had limited the opportunities they can engage in PA, as one participant commented: "I can't speak English; I can't go wherever I want by myself. Back home I knew where to go and what to do." (Somali, 67y, pre-frail)

Cultural priorities– For women of Muslim faith in particular, modesty was commonly reported as an additional barrier to PA initiation and maintenance.

Although not all Muslim participants felt uncomfortable with mixed facilities, in general, they reported a preference for gender-segregated activities.

> She is saying exercise is good, but she feels she doesn't have the facilities, she would go swimming but it is a mixed swimming and the ones with female sessions are too far to go…but she knows that swimming will be good for her arthritis and her joints […] she wouldn't go to a mixed facility because obviously your body will show. (Bangladeshi, 74y, pre-frail)

In addition, some women reported faith-related issues that prevented the uptake and maintenance of PA: "I used to [go] but I don't like the music because it's not allowed in the religion [Islam]" (Pakistani, 79y, frail). Not all women had such cultural priorities, however; this highlights the importance of planning PA facilities for an increasingly diverse UK population.

Motivators to engaging and maintaining regular PA.

This theme describes the perceived *benefits of PA.* Avoiding depression as well as preventing physical decline and maintaining independence were key factors acting as motivators to PA.

Avoiding depression– Apart from keeping the body "going", preventing depression was perceived as one of the most important benefits of PA. For some participants, attending a community center was the only activity of the day which involved leaving their homes and thus, engaging in some walking. Overall, participants felt that attending community exercise sessions was an opportunity to socialize, meet new people, and avoid negative thinking: "I think when we sit down, we have nothing to do, negativity comes in you know, so keep moving, go out, meet

people!" (Indian, 70y, pre-frail)

Preventing physical decline and maintaining independence– The influence of PA on their physical function was discussed as a motivator to engage and sustain an active lifestyle. Symptoms like "weakness" and "stiffness" were attributed to physical inactivity while, engaging in PA was perceived as beneficial for their physical function: "I'm feeling better since I started exercising, my joints are getting better as well." (Pakistani, 61y, frail)

Irrespective of frailty status or socio-demographic characteristics, participants expressed their desire to stay living in the community rather than having to go to a nursing home. "Being stuck and having people looking after you" (Indian, 62y, not-frail), appeared to be their main fear at an old age, particularly as family structures have changed and older adults cannot expect their children to look after them.

> Nobody is there to look after you; you have to look after yourself. If I start getting bigger and fatter and don't do any exercise, I will be sitting here doing nothing and nobody is going to give me [anything], not even a glass of water! (Indian, 62y, pre-frail).

This theme demonstrated the importance of community-based PA strategies among older women from diverse ethnic backgrounds. Focusing on the social component of PA will likely encourage women to engage in more PA, which may allow women to live a more socially active and independent old age.

Discussion

This study examined PA/ ST levels in a group of first generation older migrant women and their associations with frailty. Given the diversity of the sample, PA/ST

levels were also examined by ethnicity and religious affiliation. Overall, frail women tended to be more sedentary and were engaged in less LLPA and HLPA than pre-frail and non-frail participants. However, only MVPA was significantly lower in frail women.

There is a growing body of evidence showing a significant association between ST and frailty (Da Silva et al., 2016; Schwenk et al., 2015; Song et al., 2014) and other health outcomes. For instance, Patel et al. (2010) found that ≥ 6 h/day of ST was associated with higher mortality in a large cohort of adults. In a recent study, Da Silva et al. (2016) suggested that a cut-off point of 7 h/day of ST discriminated frail from non-frail older adults. Although participants in our study spent 69% of their time engaged in sedentary behavior (≥ 8 h/day), we were unable to detect a significant association between ST and frailty. This could be due to our relatively small sample size and the similarly high proportion of time spent in ST across frailty groups.

A large proportion of the general older adult population is physically inactive and may already have some physical limitations or disabilities. Thus focusing on reducing a sedentary lifestyle by increasing LPA has been suggested as a more effective way of promoting healthy ageing, instead of focusing on achieving aerobic fitness among the more sedentary and frailer older adults (Buman et al., 2010; Paterson, Jones & Rice, 2007). Nonetheless, moderate-intensity activities such as brisk walking or gardening, which increase both muscular strength and energy expenditure, should be encouraged in older adults. Similar to previous literature, we did not discriminate between moderate and vigorous PA since older adults are unlikely to engage in vigorous activity. Instead, we used the most common cut-off point to categorize all activities that are above the light intensity as MVPA (Buman et al., 2010; Blodgett et al., 2015a). In the present study, MVPA was inversely

associated with frailty after controlling for confounder factors. This finding is consistent with previous studies indicating that individuals with lower levels of MVPA are more likely to be frail, have higher levels of disability, lower limb function and higher healthcare usage (Blodgett et al., 2015a; Marques, Baptista, Santos, Silva et al., 2014; Trayers, Lawlor, Fox, Coulson et al., 2014). Although getting some activity (e.g., LPA) is better than none, lifestyle activities such as housework and low-intensity walking may not be sufficient to provide health benefits to prevent/delay physical decline in comparison to active individuals (Peterson et al., 2009). Hence, a threshold within the MVPA domain may be needed to achieve health benefits related to an active lifestyle. For instance, a recent meta-analysis indicated that about 60-75 min/day of moderate-intensity PA appeared to eliminate the increased risk of mortality associated with high sitting time among men and women (Ekelund et al., 2016).

Comparisons made by ethnicity indicated that the African/Caribbean group was the most sedentary and engaged in less HLPA than the other groups. We also examined differences by religious affiliation, as previous literature has consistently shown that PA behaviors are greatly influenced by religious beliefs (Greenhalgh et al., 1998; Curry, Duda & Thompson, 2015). In our study, women who identified as Muslim were significantly more active than those identifying as Christian. However, this difference could be explained by the fact that the majority of Christian participants were from African/Caribbean origin, who in turn, were older and more sedentary than any other ethnic group. These results contrast with what has been previously reported in the Health Survey for England (HSE), in which Black African/Caribbean women (≥ 55 years) self-reported being more active than any other ethnic group, including White and Chinese women (Sprotson & Mindell, 2006).

However, it is important to take into account that data available on the health of minority ethnic groups from the HSE were published over a decade ago and was based on self-reported data. Contemporary objectively measured PA data from women from ethnically diverse backgrounds living in the UK is limited. Using accelerometry, the HSE 2008 found that 0% of the general population of women (≥65 years) met the PA recommendations (Craig, Mindell, & Hirani, 2009). In our study, although participants were highly sedentary, 15% of the sample met the recommendations of 150 min/week in consecutive 10-minute bouts of objectively measured MVPA.

Our study also revealed key barriers for meeting PA guidelines. Consistent with the literature, physical limitations related to aging and illness are major barriers for engaging and maintaining PA (Babakus & Thompson, 2012; Horne, Skelton, Speed & Todd, 2013). Walking was the most common leisure activity recommended by health providers, and in many cases the only activity in which women engaged in. However, the negative perception of a high potential risk for injury while participating in PA highlights the fact that women may not be aware of the type of activities that can safely produce health benefits. This is particularly important for the women in this study, as most were overweight or obese, and excessive weight can cause joint pain and prevent them from being more active. Regular PA could be promoted not only as a way to prevent frailty and functional decline, but also as a way to achieve a healthier weight or optimize physical function at a given level of overweight.

Furthermore, many study participants were recruited from community centers and thus were already involved in weekly exercise sessions. However, both observations from the field and the accelerometry data confirmed that these formal exercise

sessions addressed strength, flexibility and balance, but did not address the intensity component of PA sufficiently in order to meet current PA recommendations. Whether community centers can provide higher intensity activities (e.g., dancing) is uncertain, as community-based exercise provision needs to be inclusive and meet the needs of participants across a wide range of functional abilities. Offering a range of classes across various functional abilities would require additional resources, including appropriately trained staff and the offer of more classes.

Remaining physically active was seen as a strategy to delaying physical decline, remaining independent, and preventing depression through social support. Previous qualitative studies conducted in older adults from minority backgrounds have largely recognized that the social component of PA may be even more important than the physical health benefits such as managing chronic diseases (Caperchione et al., 2009; Horne, Skelton, Speed & Todd, 2012). Similarly, maintaining independence is a major motivator in engaging in regular PA and it is particularly important in this population, as some women have familial expectations that are different from those of Western countries (Harper & Levin, 2005). Namely, moving older adults into nursing homes as they age is considered culturally unacceptable according to some of the participants in the present study.

As the UK and other developed countries become increasingly diverse, it is important to ensure the health and well-being of migrant groups. While some women may be comfortable in using PA services already available for older adults (e.g., walking clubs, mixed facilities), many others may face important barriers such as lack of English proficiency and cultural norms that have been consistently reported in ethnic minorities living in the UK (Greenhalgh, Helman, & Chowdhury, 1998; Horne & Tierney, 2012; Sriskantharajah & Kai, 2007). These barriers may be even more

important than the lack of knowledge of health benefits related to PA. Consideration should also be given to how older women are able to negotiate their responsibilities towards their families. This is important to address in future strategies that encourage women to engage in leisure PA, as programs that do not interfere with their household responsibilities may be more attractive and acceptable to older migrant women.

The mixed-methods design used in this study provided useful insights of objectively measured PA/ST in women with varying frailty status from diverse ethnic backgrounds, a population that is commonly under-represented in research. However, we acknowledge that this study has some limitations. Although we used the most well validated accelerometer (ActiGraph), a limitation of this monitor is that it does not distinguish between sitting, lying down or standing, which may provide more precise information about sedentary behavior. Furthermore, accelerometry compliance in our study was lower (79% vs 91%) than what has been reported in an earlier study conducted among South Asian women in the UK (Curry & Thompson, 2014).

We employed several strategies to improve compliance such as text messages, telephone calls and a pictorial log as well as employing interpreters of the same ethno-cultural background and gender as the participants. Nonetheless, compliance from non-English speakers was lower than for women with English literacy (63 vs. 88%). Collecting objective measures of PA is challenging among ethnic minorities (Pollard & Guell, 2012). However, the use of activity monitors is crucial in order to obtain accurate ST/PA data from ethnic minorities. To date, the few studies that have assessed objective measures of PA in mainly South Asian populations (including Muslim women) have reported higher levels of PA than what has been estimated via self-reported tools (Kolt, Schofield, Rush, Oliver & Chadha, 2007; Curry & Thompson, 2014). Obtaining accurate PA/ST data will help scholars, health

professionals and policy makers gain a deeper understanding of ST/PA levels in this population so that effective PA strategies can be developed. This will also help avoiding stereotyping ethnic minorities as inherently inactive in comparison to the general population.

Employing interpreters to include voices of 'hard-to-reach' migrant groups (e.g., Somali, Bangladeshi and Arabic women), which is considered a strength, had some disadvantages. For instance, six women were lost to follow-up due to an obstructive gatekeeper/interpreter, and one participant refused to wear the monitor due to trust issues. Recruiting participants from close-knit communities poses additional challenges because some members can be suspicious of outsiders (Spring, Westermeyer, Halcon, Savik et al., 2003). Although investing in communities to build rapport requires time and additional resources, the disproportionate health disparities these groups face indicate the need to ensure they are included in research (Redwood & Gill, 2013). Given the limited time and resources available, we were unable to engage longer with these communities. Similarly, we were unable to account for the effect of the interpreters on the qualitative phase of the study, which may have limited the language trustworthiness and consequently, the transferability of the translated data (Squires, 2009).

As an additional point, we would like to draw attention to important issues when assessing frailty in older adults. The frailty phenotype has been previously suggested as not being sensitive enough to identify frailty, as cognitive impairment and comorbidities are not included in the frailty definition (Clegg et al., 2013; Blodgett, Theou, Kirkland, Andreou & Rockwood, 2015b). Among women from diverse ethnic backgrounds, obesity and its related comorbidities are disproportionally higher than the general population (Caperchione et al., 2009). In our sample, 88% of

women were either overweight or obese, with some women reporting being diagnosed with diabetes and/or cardiovascular disease in their early 40s or 50s. Interview data showed that chronic diseases and their complications were commonly mentioned as affecting one's ability to engage in more active lifestyles. As such, it is possible that comorbidities in women from ethnic minorities have a greater influence on the onset of frailty. Our relatively small sample size and the cross-sectional design of the study did not allow us to explore this further.

Furthermore, our data suggest that women with low PA levels, reduced walking speed, and poor nutritional status tended to be more susceptible to frailty. In accordance to previous studies, poor nutritional status and low intake of specific nutrients have been suggested to be an important component of frailty among older adults (Bartali et al., 2006; Bartali, Curto, Maserejian & Araujo, 2015; XXX et al., in press). Identifying these factors in advance may be crucial in order to prevent or delay the onset of frailty. Additionally, assessing frailty and ST/PA levels not only by ethnicity but by other socio-demographic factors (e.g., religious affiliation, migration background, etc.) in greater depth is also needed to be able to detect important differences between groups that can be targeted successfully in future PA interventions. In order to explore these important lines of inquiry, a larger and longitudinal study would be required.

Conclusions

This sample of first generation migrant women was highly sedentary irrespective of their frailty status. The finding that MVPA is associated with frailty suggests that increasing MVPA may promote healthy aging by decreasing the risk of frailty. Light-intensity activities such as walking were the main activities participants

engaged in; however, these activities may not be sufficient to promote health benefits among this population. Future interventions to promote active lifestyles for older women need to provide detailed information on specific activities that are both safe and of sufficient intensity to optimize health and physical function. This study also provided useful insights into the PA/ST levels between ethnicity and religious groups, and key barriers and motivators to adhering to PA guidelines. By understanding key factors influencing PA behaviors in older migrant women from ethnically diverse backgrounds, PA strategies can be tailored to this population in order to maximize their effectiveness.

Acknowledgements

The authors thank the study participants, their families and community leaders who made this study possible.

References

Babakus, W. S., & Thompson, J. L. (2012). Physical activity among South Asian women: A systematic, mixed-methods review. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 150. doi:10.1186/1479-5868-9-150

Bartali, B., Frongillo, E. A., Bandinelli, S., Lauretani, F., Semba, R. D., Fried, L. P., & Ferrucci, L. (2006). Low nutrient intake is an essential component of frailty in older persons. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *61*, 589-593.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77-101. doi:10.1191/1478088706qp063oa

Blodgett, J., Theou, O., Kirkland, S., Andreou, P., & Rockwood, K. (2015a). The association between sedentary behaviour, moderate–vigorous physical activity and frailty in NHANES cohorts. *Maturitas, 80*, 187-191. doi:10.1016/j.maturitas.2014.11.010

Blodgett, J., Theou, O., Kirkland, S., Andreou, P., & Rockwood, K. (2015b). Frailty in NHANES: Comparing the frailty index and phenotype. *Archives of gerontology and geriatrics, 60*, 464-470. doi: 10.1016/j.archger.2015.01.016

Boyd, C. M., Xue, Q. L., Simpson, C. F., Guralnik, J. M., & Fried, L. P. (2005). Frailty, hospitalization, and progression of disability in a cohort of disabled older women. *American Journal of Medicine, 118*, 1225-1231. doi:10.1016/j.amjmed.2005.01.062

Buman, M. P., Hekler, E. B., Haskell, W. L., Pruitt, L., Conway, T. L., Cain, K. L., . . . King, A. C. (2010). Objective light-intensity physical activity associations

with rated health in older adults. *American Journal of Epidemiology, 172*, 1155-1165. doi:10.1093/aje/kwq249

Caperchione, C. M., Kolt, G. S., & Mummery, W. K. (2009). Physical activity in culturally and linguistically diverse migrant groups to Western society: A review of barriers, enablers and experiences. *Sports Medicine, 39*, 167-177. doi:10.2165/00007256-200939030-00001

Castaneda-Gameros, D., Redwood, S., & Thompson, J. L. (2017). Low Nutrient Intake and Frailty Among Overweight and Obese Migrant Women From Ethnically Diverse Backgrounds Ages 60 Years and Older: A Mixed-Methods Study. *Journal of Nutrition Education and Behavior, 49,* 3-10. doi: 10.1016/j.jneb.2016.08.006

Choi, L., Ward, S. C., Schnelle, J. F., & Buchowski, M. S. (2012). Assessment of Wear/Nonwear Time Classification Algorithms for Triaxial Accelerometer. *Medicine & Science in Sports & Exercise, 44*, 2009-2016. doi:10.1249/MSS.0b013e318258cb36

Christensen, K., Doblhammer, G., Rau, R., & Vaupel, J. W. (2009). Ageing populations: The challenges ahead. *Lancet, 374*, 1196-1208. doi:10.1016/S0140-6736(09)61460-4

Clegg, A., Young, J., Iliffe, S., Rikkert, M. O., & Rockwood, K. (2013). Frailty in elderly people. *The Lancet, 381*, 752-762. doi:10.1016/S0140-6736(12)62167-9

Copeland, J.L., & Esliger, D. W. (2009). Accelerometer Assessment of Physical Activity in Active, Healthy Older Adults. *Journal of Aging and Physical Activity, 17*, 17-30. doi:10.1123/japa.17.1.17

Craig, R., Mindell, J., & Hirani, V. (2009). *Health Survey for England 2008: Physical Activity and Fitness*. The Health and Social Care Information Centre.

Cruz-Jentoft, A.J., Baeyens, J. P., Bauer, J. M., Boirie, Y., Cederholm, T., Landi, F., ... & Topinková, E. (2010). Sarcopenia: European consensus on definition and diagnosis Report of the European Working Group on Sarcopenia in Older People. *Age and ageing*, afq034.

Curry, W. B., Duda, J. L., & Thompson, J. L. (2015). Perceived and Objectively Measured Physical Activity and Sedentary Time among South Asian Women in the UK. *International Journal of Environmental Research and Public Health, 12*, 3152-3173. doi:10.3390/ijerph120303152

Curry, W. B., & Thompson, J. L. (2014). Objectively measured physical activity and sedentary time in South Asian women: A cross-sectional study. *BMC Public Health, 14*. doi: 10.1186/1471-2458-14-1269

Da Silva, C. R., De Queiroz, B. M., Oliveira, D. S., Das, M. M., Carneiro, J. A., Pereira, R., & Fernandes, M. H. (2016). Cross-sectional relationships between sedentary behavior and frailty in older adults. *The Journal of Sports Medicine and Physical Fitness*. [Epub ahead of print]

Department for Communities and Local Government. (2011). *English indices of deprivation.* Retrieved from https://www.gov.uk/government/collections/english-indices-of-deprivation

Department of Health. (2011). *UK Department of Health. Physical activity guideline for older adults (65+ years)*. Retrieved from https://www.gov.uk/government/publications/uk-physical-activity-guidelines

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., ... & Lancet Sedentary Behaviour Working Group. (2016).

Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *The Lancet*, 388, 1302-1310. doi: 10.1016/ S0140-6736(16)30370-1

Ensrud, K. E., Ewing, S. K., Taylor, B. C., Fink, H. A., Stone, K. L., Cauley, J. A., . . . Study of Osteoporotic Fractures Research, G. (2007). Frailty and risk of falls, fracture, and mortality in older women: The study of osteoporotic fractures. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 62*, 744-751.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., . . . Cardiovascular Health Study Collaborative Research, G. (2001). Frailty in older adults: Evidence for a phenotype. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 56*, M146-156.

Greenhalgh, T., Helman, C., & Chowdhury, A. M. (1998). Health beliefs and folk models of diabetes in British Bangladeshis: A qualitative study. *British Medical Journal, 316*, 978-983. doi:10.1136/bmj.316.7136.978

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18*, 59-82. doi: 10.1177/1525822X05279903

Harper, S., & Levin, S. (2005). Family care, independent living and ethnicity. *Social Policy and Society, 4*, 157-169. doi: 10.1017/S1474746404002295

Horne, M., Skelton, D. A., Speed, S., & Todd, C. (2012). Attitudes and beliefs to the uptake and maintenance of physical activity among community-dwelling South Asians aged 60-70 years: A qualitative study. *Public Health, 126*, 417-423. doi:10.1016/j.puhe.2012.02.002

Horne, M., Skelton, D. A., Speed, S., & Todd, C. (2013). Perceived barriers to initiating and maintaining physical activity among South Asian and White British adults in their 60s living in the United Kingdom: A qualitative study. *Ethnicity & Health, 18*, 626-645. doi:Doi 10.1080/13557858.2013.814762

Horne, M., & Tierney, S. (2012). What are the barriers and facilitators to exercise and physical activity uptake and adherence among South Asian older adults: A systematic review of qualitative studies. *Preventive Medicine, 55*, 276-284. doi:10.1016/j.ypmed.2012.07.016

Kolt, G. S., Schofield, G. M., Rush, E. C., Oliver, M., & Chadha, N. K. (2007). Body fatness, physical activity, and nutritional behaviours in Asian Indian immigrants to New Zealand. *Asia Pacific Journal of Clinical Nutrition, 16*, 663-670. doi:10.6133/apjcn.2007.16.4.11

Marques, E. A., Baptista, F., Santos, D. A., Silva, A. M., Mota, J., & Sardinha, L. B. (2014). Risk for losing physical independence in older adults: The role of sedentary time, light, and moderate to vigorous physical activity. *Maturitas, 79*, 91-95. doi:10.1016/j.maturitas.2014.06.012

Matthews, C. E., Moore, S. C., Sampson, J., Blair, A., Xiao, Q., Keadle, S. K., . . . Park, Y. (2015). Mortality Benefits for Replacing Sitting Time with Different Physical Activities. *Medicine & Science in Sports & Exercise, 47*, 1833-1840. doi:10.1249/MSS.0000000000000621

Patel, A. V., Bernstein, L., Deka, A., Feigelson, H. S., Campbell, P. T., Gapstur, S. M., ... & Thun, M. J. (2010). Leisure time spent sitting in relation to total mortality in a prospective cohort of US adults. *American Journal of Epidemiology*, *172*, 419-429. doi: 10.1093/aje/kwq155

Paterson, D. H., Jones, G. R., & Rice, C. L. (2007). Ageing and physical activity:

Evidence to develop exercise recommendations for older adults. *Applied Physiology, Nutrition, and Metabolism, 32,* S69-S108.

Peterson, M. J., Giuliani, C., Morey, M. C., Pieper, C. F., Evenson, K. R., Mercer, V., . . . Body Composition Study Research, G. (2009). Physical activity as a preventative factor for frailty: The health, aging, and body composition study. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 64,* 61-68. doi:10.1093/gerona/gln001

Pollard, T. M., & Guell, C. (2012). Assessing physical activity in Muslim women of South Asian origin. *Journal of Physical Activity and Health, 9,* 970.

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385-401.

Rechel, B., Grundy, E., Robine, J. M., Cylus, J., Mackenbach, J. P., Knai, C., & McKee, M. (2013). Ageing in the European Union. *Lancet, 381,* 1312-1322. doi:10.1016/S0140-6736(12)62087-X

Redwood, S., & Gill, P. S. (2013). Under-representation of minority ethnic groups in research—call for action. *British Journal of General Practice, 63,* 342-343. doi: 10.1093/fampra/cms054

Schwenk, M., Mohler, J., Wendel, C., D'Huyvetter, K., Fain, M., Taylor-Piliae, R., … (2015). Wearable sensor-based in-home assessment of gait, balance, and physical activity for discrimination of frailty status: Baseline results of the Arizona Frailty Cohort Study. *Gerontology, 61,* 258-67. doi: 10.1159/000369095.

Song, J., Lee, A. L., Chang, R. W., Semanik, P.A., Ehrlich- Jones, L.S., Lee, J., Sohn M., … (2015). Sedentary behavior and physical function: Objective evidence

from the osteoarthritis initiative. *Arthritis Care & Research, 67*, 366-373. doi: 10.1002/acr.22432

Spring, M., Westermeyer, J., Halcon, L., Savik, K., Robertson, C., Johnson, D. R., . . . Jaranson, J. (2003). Sampling in difficult to access refugee and immigrant communities. *Journal of Nervous & Mental Diseases, 191*, 813-819.

Sprotson, K., & Mindell, J. (2006). Health Survey for England 2004: Health of Ethnic Minorities-Summary of Key Findings. *Leeds, UK: The Information Centre*.

Squires, A. (2009). Methodological challenges in cross-language qualitative research: a research review. *International Journal of Nursing Studies, 46*, 277-287. doi: 10.1016/j.ijnurstu.2008.08.006

Sriskantharajah, J., & Kai, J. (2007). Promoting physical activity among South Asian women with coronary heart disease and diabetes: what might help? *Family Practice, 24*, 71-76. doi:10.1093/fampra/cml066

Teddlie, C., & Yu, F. (2007). Mixed methods sampling a typology with examples. *Journal of Mixed Methods Research, 1*, 77-100. doi:10.1177/2345678906292430

Trayers, T., Lawlor, D. A., Fox, K. R., Coulson, J., Davis, M., Stathi, A., & Peters, T. (2014). Associations of objectively measured physical activity with lower limb function in older men and women: Findings from the Older People and Active Living (OPAL) study. *Journal of Aging and Physical Activity, 22*, 34-43. doi:10.1123/japa.2012-0087

WHO., E.C. (2014). Appropiate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*, 363, 157-163. doi:10.1016/S0140-6736(03)15268-3

Table 1
Participant characteristics

Variables	All (n=60)	Non-frail (n=23)	Pre-frail (n=27)	Frail (n=10)
	M (SD)			
Age (years)	70.8 (8.1)	67.8 (5.6)	71.6 (8.6)	75.5 (9.4) [a]
Number of comorbidities	2.4 (1.6)	2.0 (1.5)	2.3 (1.7)	3.2 (1.3)
BMI (kg/m^2)	29.4 (4.8)	29.0 (4.1)	29.9 (5.7)	28.9 (3.4)
	n (%)			
BMI category				
Normal	7 (11.7)	3 (13.0)	4 (14.8)	0 (0.0)
Overweight	18 (30.0)	8 (34.8)	6 (22.2)	4 (40.0)
Obese	35 (58.3)	12 (52.2)	17 (63.0)	6 (60.0)
Ethnicity				
South Asian	25 (41.7)	10 (43.5)	12 (40.7)	4 (40.0)
African/ Caribbean	23 (38.3)	8 (34.7)	10 (37.0)	5 (50.0)
Arab	8 (13.3)	2 (8.7)	5 (18.5)	1 (10.0)
White Irish	4 (6.7)	3 (13.0)	1 (3.7)	0 (0.0)
Religion				
Christian	25 (41.7)	10 (43.5)	10 (37.0)	5 (50.0)
Muslim	22 (36.7)	9 (39.1)	9 (33.3)	4 (40.0)
Hindu/Sikh	13 (21.7)	4 (17.3)	8 (29.6)	1 (10.0)
Migration status				
Family reunification	34 (58.3)	14 (60.9)	15 (55.6)	4 (40.0)
Economic migrant	22 (36.7)	8 (34.8)	10 (37.0)	6 (60.0)
Refugee/asylum seeker	4 (5.0)	1 (4.3)	2 (7.4)	0 (0.0)
Marital status				
Partner (yes)	30 (50.0)	16 (60.9)	13 (55.6)	1 (10)[b]
IMD quintile				
1	37 (61.7)	15 (56.5)	13 (55.6)	9 (90.0)
2	9 (15.0)	2 (8.7)	7 (25.6)	0 (0.0)
3	6 (10.0)	2 (8.7)	4 (14.8)	0 (0.0)
4-5 (least deprived)	8 (13.3)	6 (26.1)	2 (3.7)	1 (10.0)
Meeting PA weekly recommendations	9 (15.0)	3 (13.0)	5 (22.2)	0 (0.0)
Frailty criteria				
Exhaustion	11 (38.3)		5 (18.5)	6 (60.0)
Weakness	10 (16.7)		5 (18.5)	4 (40.0)

Slow walking	17 (28.3)	N/A	10 (37.0)	7 (70.0)[c]
Low PA	12 (20.0)		5 (18.5)	7 (70.0)[c]
Poor nutritional status	19 (31.7)		10 (37.0)	9 (90.0)[c]

BMI=body mass index; IMD= index of multiple deprivation; PA= physical activity; N/A= not applicable, [a] Different from non-frail participants only ($p=0.03$), [b] Different from pre-frail ($p=0.01$) and non-frail ($p<0.01$) participants, [c] Different from frail participants only ($p<0.05$)

Table 2

Accelerometer derived variables between frail groups

Variables[a]	All (n=60)	Non-frail (n=23)	Pre-frail (n=27)	Frail (n=10)	Sig. (p)
ST (min/day)	536.8 (87.9)	523.7 (85.7)	533.1 (85.7)	576.7 (7.0)	0.48
LLPA (min/day)	198.6 (64.8)	207.4 (57.8)	204.9 (66.7)	161.4 (68.7)	0.51
HLPA (min/day)	26.9 (17.2)	27.1 (13.6)	29.8 (17.2)	18.4 (23.0)	0.36
MVPA (min/day)[b]	16.0 (17.9)	18.4 (19.9)	18.7 (17.6)	3.4 (4.5)[c]	<0.01

Data are presented in *M (SD)*, ST= sedentary time, LLPA= low-light physical activity, HLPA= high-low physical activity, MVPA= moderate-to-vigorous activity; [a]Adjusted for age and wear time; [b] Log-transformed data were used for analysis, actual means included for clarity of interpretation, [c] Different from non-frail ($p=0.02$) and pre-frail participants ($p<0.01$)

Table 3

Accelerometer derived variables (min/day) by ethnicity and religious groups

Variables [a]	N	ST	LLPA	HLPA	MVPA
		by ethnicity			
South Asian	25	532.8 (102.4)	207.9 (69.6)	30.2 (19.2)	20.0 (21.4)
African/	23	570.1 (70.6)[b]	168.9 (60.0)[c]	16.8 (11.7)[b]	9.5 (11.0)
Caribbean	12	481.2 (53.2)	236.1 (34.6)	39.2 (10.6)	20.3 (18.2)
Other					
		by religion			
Christian	25	558.1 (71.1)	213.2 (56.5)	36.4 (18.9) [d]	19.6 (18.9)
Muslim	22	505.5 (98.2)	213.1 (72.9)	26.5 (13.6)	22.6 (22.9)
Hindu/Sikh	13	548.8 (89.9)	178.3 (64.4)	18.6 (12.9)	9.4 (11.4)

Data are presented in *M (SD)*, ST= sedentary time, LLPA= low-light physical activity, HLPA= high-low physical activity, MVPA= moderate-to-vigorous physical activity, [a] Adjusted by age and wear time, [b] Different from SA and 'other' ethnic group ($p<0.04$), [c] Different from 'other' group only ($p=0.01$), [d] Different from Muslim participants only ($p=0.02$).

Table 4

Regression models examining significant predictors of frailty[a]

Model	Variable	B	SE (B)	β	t	Sig. (p)	Adj. R^2
1	Age	0.01	0.02	0.07	0.54	0.59	0.384
	No.	0.17	0.07	0.26	2.32	0.02	
	comorbidities	-0.85	0.22	-0.42	-3.93	<0.001	
	Marital status[b]	0.00	0.00	0.07	0.64	0.53	
	Wear time	**-0.46**	**0.21**	**-0.29**	**-2.22**	**0.03**	
	MVPA[c]						
2	Age	0.02	0.02	0.15	1.09	0.28	0.381
	No.	0.14	0.07	0.22	1.86	0.07	
	comorbidities	-0.92	0.23	-0.46	-4.04	<0.001	
	Marital status[b]	-0.00	0.03	-0.02	-0.17	0.86	
	BMI	0.00	0.01	0.05	0.43	0.77	
	IMD						
	Religion[d]						
	Hindu/Sikh	0.05	0.30	0.02	0.18	0.86	
	Christian	-0.47	0.28	-0.23	-1.69	0.09	
	Wear time	0.00	0.00	0.07	0.44	0.66	
	ST	-0.00	0.00	-0.04	-0.27	0.79	
	MVPA[c]	**-0.54**	**0.24**	**-0.34**	**-2.28**	**0.04**	

MVPA= Moderate-to-vigorous activity; BMI= body mass index; IMD= index of multiple deprivation; ST= sedentary time; [a] Frailty score (total number of components of the frailty phenotype excluding self-reported PA); [b] Marital status (Reference: with partner); [c] log transformed for analysis; [d] Religion (Reference: Muslim).

Table 5

Key themes from interviews

Themes	Sub-themes
Perceived barriers to meeting PA guidelines	***Health-related***
	Physical limitations and pain
	Different physical abilities
	Weight issues
	Socio-cultural factors
	Conflicting schedules
	Language barriers
	Cultural priorities
Motivators to engaging and maintaining regular PA	***Benefits of PA***
	Avoiding depression
	Preventing physical decline and maintaining independence